



Design and Implementation of Intelligent Crime Information and Analysis System (ICIAS) Based on Crime Data Mining

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Abstract— Security is the key concern for any Nation's defense system. There has been an enormous increase in the crime in the recent past like 9/11 terrorist attack on United States, 26/11 Mumbai attack in India, 13 Nov. 2015 Paris attack in France, etc. Any act that causes loss of lives and harms people is called as crime. Crime analysis is a task that includes exploring and detecting crimes and their relationships with criminals. Presently there are several crime analysis tools available in the market. The main aim of this paper is to present a detailed study of the existing computer aided crime analysis software and tools available. They provide useful information about the crimes and criminals but do not help for the purpose of designing an action to prevent the crime. It has become a major challenge for any police system to detect and prevent crimes before happening and results in reducing the increased crime rate. This paper also highlights the importance of data mining technology to design Intelligent Crime Information and Analysis System (ICIAS) to reduce crime incidences in the police stations jurisdiction. The proposed system is used to extract useful information from the vast crime database and find crime hot spots using crime data mining techniques.

Keywords— Crime, Criminology, Crime Analysis tools, CCIS, CIPA, Crime Data Mining

I. INTRODUCTION

Criminology is an area that focuses the scientific study of crime and criminal behavior and law enforcement [1]. It is a process that aims to identify crime characteristics. It is one of the most important fields where the application of data mining techniques can produce important results. Crime analysis, a part of criminology, is a task that includes exploring and detecting crimes and their relationships with criminals [1]. Applying data mining techniques made criminology an appropriate field due to the high volume of crime datasets and also the complexity of relationships between these kinds of data. The first step is the identification of crime characteristics for developing further analysis. The knowledge gained from data mining approaches is a very useful tool that helps and supports police forces. According to Nath (2007), solving crimes is a complex task that requires human intelligence and experience and data mining is a technique that can assist them with crime detection problems. The criminals are becoming technologically aware in committing crimes. Therefore, police needs such a crime analysis tool to catch criminals and to remain ahead in the eternal race between the criminals and the law enforcement [1]. The police should use the current technologies to give themselves the much-needed edge. In crime investigation and detection of criminals, availability of relevant and timely information is of utmost necessity in conducting daily activities by the police stations. The crime analysis should be able to identify crime patterns quickly and in an efficient manner for future crime pattern detection and action.

The applications of data mining techniques can discover important knowledge about crime and criminals. It is always desirable to have a crime analysis tool that can discover the necessary crime knowledge from the huge database and aid to identify crime details accurately in a time efficient manner [2]. It can improve the most challenging decision-driven criminal investigations. The discovered knowledge can then be used for future crime pattern detection and action. Presently, there are several crime analysis tools that help police officials. The main goal of this paper is to discuss the current status of the crime analysis tools available all over world with particular emphasis to Indian state of affairs. This paper also describes design and implementation of Intelligent Crime Information and Analysis System (ICIAS).

II. RELATED WORK

A. Existing Computer Aided Crime Analysis Tools

This section presents a brief discussion on the existing software programs designed for crime analysis (Boba, 2003).

Table 1 Existing Computer Aided Crime Analysis Tools

	Crime Analysis software/tool	Description
1.	ATAC	✓ allows data entry, manipulation, and analysis ✓ also provides temporal analysis and a function that identifies potential crime patterns
2.	Crime Analysis Extension	✓ free mapping software developed through a partnership

		between the U.S. government and a software vendor
3.	CrimeStat	✓ spatial statistical software works with GIS software to allow users to conduct analyses with various techniques using incident locations
4.	CrimeView software	✓ links directly to an agency's CAD system or RMS and provides specific crime mapping and analysis techniques
5.	GeoBalance redistricting software	✓ identifies the best possible arrangement of police areas (such as beats and districts) based on several statistics
6.	RCAGIS (Regional Crime Analysis Geographic Information System)	<ul style="list-style-type: none"> ✓ intended for use by numerous agencies in a region with the same data format (all the data are linked into the software automatically) ✓ also includes various crime analysis and crime mapping functions
7.	School COP (School Crime Operations Package)	✓ specifically designed to allow users to enter, analyze, and map incidents that occur in and around schools
8.	StaffWizard	✓ helps to optimize the placement of current staff (patrol deployment) as well as determine staffing needs
9.	CrimeConnect	<ul style="list-style-type: none"> ✓ secure Web-based tactical crime information sharing system that enables multiple police jurisdictions to share information such as Wanted, Missing Persons, Sex Crime Registrants, Bulletins, etc. in real time. ✓ also enables authorized department personnel to search the tactical crime databases and selected data from the Records Management Systems of multiple jurisdictions to enhance the police officer's ability to solve crime (Dhananjay, 2006)
10.	CrimePointWeb	<ul style="list-style-type: none"> ✓ web based software solution that facilitates information sharing, analysis and management for law enforcement and public safety agencies ✓ can take information i.e. both data and analysis to where it is needed most (Forensic Logic, 2011)
11.	AC ²	<ul style="list-style-type: none"> ✓ user-friendly and powerful system that provides a comprehensive set of tools to access, select, prepare, and manipulate data. ✓ based on an Object-Oriented language that allows the user to structure the data and enrich this structure with the user's domain knowledge. ✓ builds predictive models automatically which are displayed in the form of decision trees. ✓ easily tested and validated and deploy in the areas such as segmentation, classification, estimation, and prediction. ✓ comprehensive toolkit that allows one to perform advanced Data Mining tasks and develop powerful decision support systems step-by-step
12.	CART	<ul style="list-style-type: none"> ✓ robust, easy-to-use decision tree tool that automatically sifts large, complex databases, searching for and isolating significant patterns and relationships. ✓ used to generate reliable, easy-to-grasp predictive models for applications such as profiling customers, targeting direct mailings, detecting telecommunications and credit card fraud, and managing credit risk. ✓ excellent pre-processing complement to other data analysis techniques. ✓ For example, CART's outputs (predicted values) can be used as inputs to improve the predictive accuracy of neural nets and logistic regression
13.	BRAINCEL	<ul style="list-style-type: none"> ✓ easy to use Excel add-in that enhances forecasts with the power of neural networks ✓ has a BESTNET option that directs the program to find the best neural net size and shape
14.	BrainMaker Neural Network	✓ lets one use their computer for business and marketing

	Software	<ul style="list-style-type: none"> forecasting, stock, bond, commodity, and futures prediction, pattern recognition, medical diagnosis, sports handicapping etc ✓ lets to watch the network learn and easily finds a network that test well ✓ uses the Back Propagation algorithm ✓ shows Network Progress Display graphically and shows how well the network is learning ✓ also helps to determine the accuracy level
15.	CrimeStat III	<ul style="list-style-type: none"> ✓ spatial statistics program for the analysis of crime incident locations, developed by Ned Levine & Associates under grant from the National Institute of Justice. ✓ Windows-based program and interfaces with most desktop GIS programs ✓ provides supplemental statistical tools to aid law enforcement agencies and efforts ✓ used by many police departments around the country as well as by criminal justice and other researchers
16.	CrimeStat III Version3.0	<ul style="list-style-type: none"> ✓ available free of charge ✓ program inputs incident locations (e.g., robbery locations) in 'dbf', 'shp', ASCII or ODBC-compliant formats using either spherical or projected coordinates ✓ calculates various spatial statistics and writes graphical objects to ArcView, MapInfo, Atlas*GISTM, Surfer for Windows, and ArcView Spatial Analyst (Bangar, 2011)

In addition to these commercially produced programs, many police departments have created their own software to perform crime analysis. Different software is used to create the tool. They range from the simplest (Microsoft Access) to advanced computer program (Java / .NET). Often, in spite of the growing commercial and open-source software tools, crime analysts and agencies find it difficult to find off-the-shelf software to fit with their data [3]. The need and requirement changes from country-to-country, sometimes even state-to-state. As a result, research in finding a sophisticated solution still is on-going.

B. Computer Aided Crime Analysis Tools in India

Police enforcement is a prominent part of civil administration and law enforcement, especially in countries like India. India being one of the most populous countries in the world encompasses 1.5 million police force. The State level police forces are assigned the responsibility for maintaining law and order in the states and territories. Therefore, police functioning has been the area of foremost concern for the government and incessant endeavours are put forth for its enhancement. National Crime Record Bureau (NCRB) has been initiated by the Government of India in 1986, and for its proper functioning the government created State Crime Record Bureaux (SCRbX) at State level and District Crime Record Bureaux (DCRBx) at District level [4]. Information Control and distribution has become a prior area of concern for the police owing to the changes undergoing in the environment. This is a time consuming process. However, in order to carry out a proper investigation an advanced and meaningful crime analysis tool is needed.

1) *Crime and Criminal Information System (CCIS)*: Crime Criminal Information System (CCIS) forms a major sharable database on crime and criminals. It assists in carrying out investigations and supervising officers and police planners to create strategies for controlling crime at district, state and national level. It has been further upgraded as a multi-lingual application in the year 2005 to CCIS MLe for various local languages i.e. Marathi, Gujarati, Tamil, Kannada and Gurumukhi besides English and Hindi. This is an internet based application which facilitates the supervisory officers to access the CCIS databases at National and State level, irrespective of time and place. CCIS is one of the major police applications in the world which is carried out at 35 States and UTs, 727 police districts and at national level [5]. The primary source of information in CCIS is police station. A Government to Government (G2G) model has been approved by the Government of India, which has been designed to create a computerised storage analysis and retrieval of crime and criminal records. At present, the CCIS is functioning in all the states.

2) *Common Integrated Police Application (CIPA)*: The main objective of creating Common Integrated Police Application (CIPA) was to automatize the work flow at police stations and to form a Crime & Criminal Information System. It emphasises on the automation of all functions carried out at police stations which happen to be the primary source of information. CIPA has been created and developed in English language by NIC, with multilingual interface developed for Indian languages. The project basically aims at functioning in a proper mechanism and infrastructure for the development of CCIS (Crime and Criminal Information System) which is run with uniformity throughout the country. CIPA was created for the better management of public order and criminal activities, with the effective usage of Information Technology. There are three important modules of the software viz.. Registration, Investigation and Prosecution. The first module comprises of FIR Registration process and after the staff becomes familiarised with its

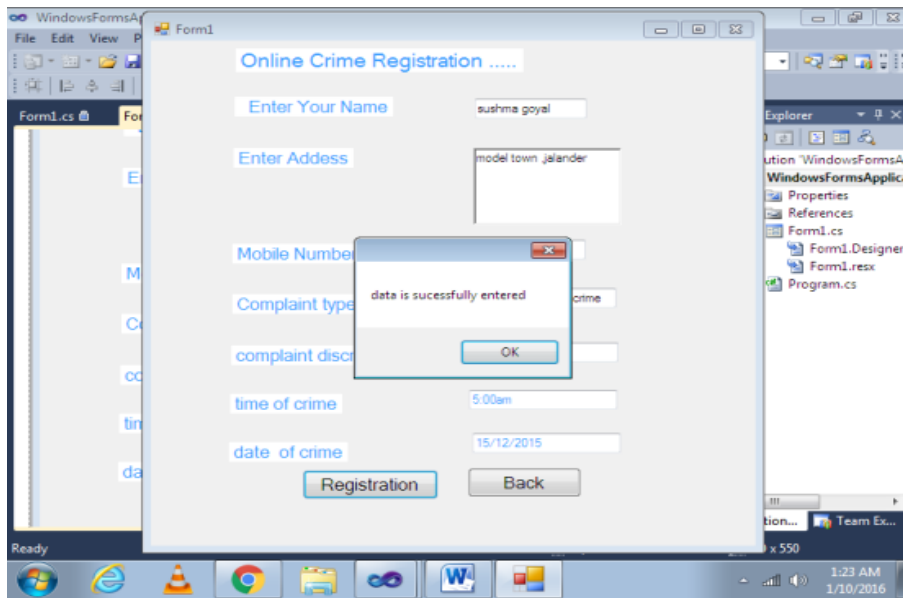
working, further processes like Investigation are made to be computerised. The functioning of CIPA would enhance the accessibility, transparency and accountability in the working of police department which would facilitate the police stations to work more efficaciously. At present NIC has implemented both CIPA and CCIS whereas monitoring and coordination are being handled by NCRB. Police stations are implementing CIPA project in different phases. By 2007, nearly 10% of police stations have been covered throughout the country which constitutes to be approx 1400 police stations. 30% of police stations (approx 3700 police stations) will be initiated in the second phase and the remaining in the final phase [6]. All the police stations of Delhi have implemented CIPA.

III. INTELLIGENT CRIME INFORMATION AND ANALYSIS SYSTEM (ICIAS)

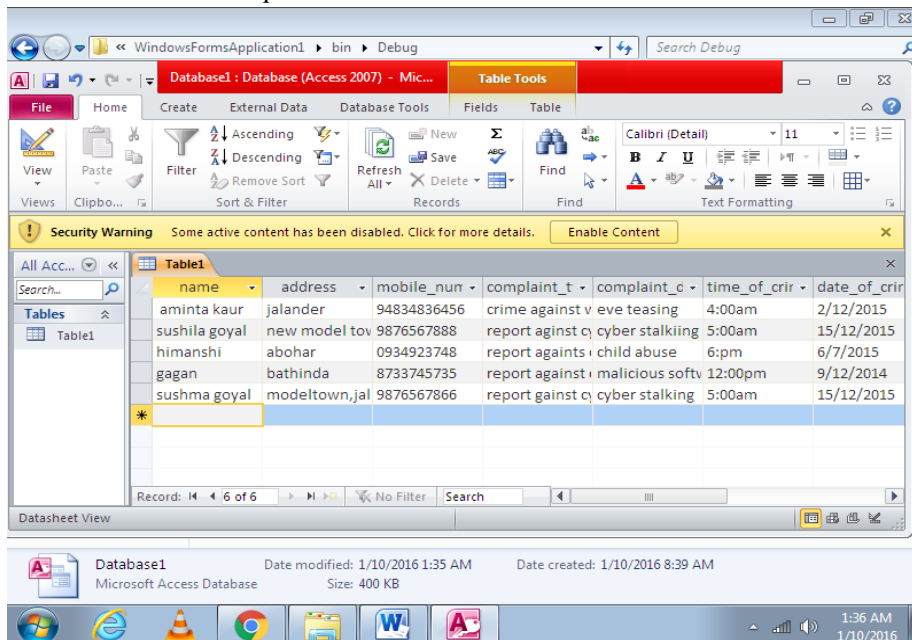
In today's world criminals have become techno savvy and they make maximum use of all the modern technologies and methods in committing crimes. This has facilitated them in operating over the length and breadth of the country also. If we have to effectively meet out challenges of crime control and maintenance of public order, creation of databases on crimes & criminals in digital form for sharing by all, an intelligent police information system (Chen, et al., 2003; Ozkan, 2004) cannot be neglected anymore [7]. This section highlights the need for Crime Analysis Tool as interactive interface and describes the Intelligent Crime Information and Analysis system based on Crime Data Mining.

A. Crime Data Entry Module

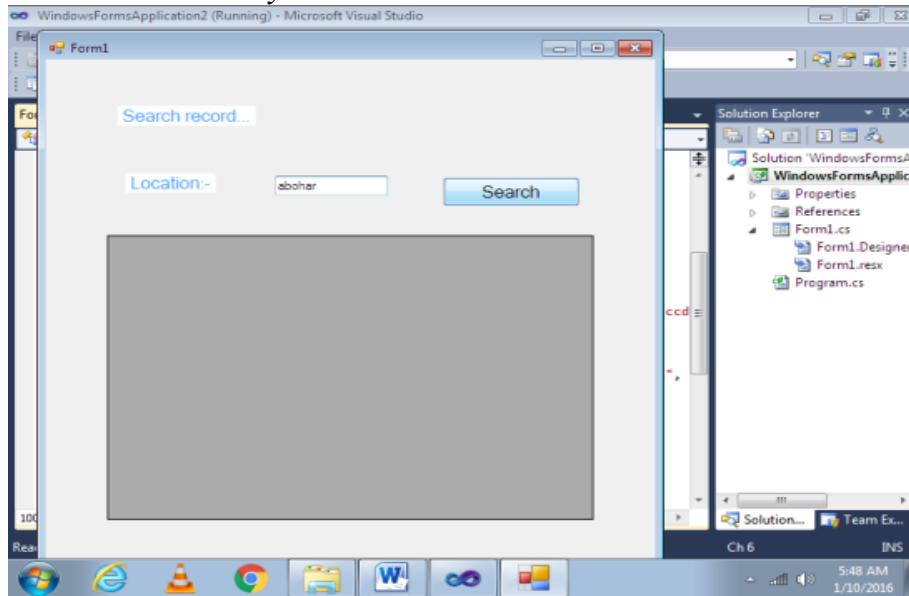
Crime data entry module deals with entering data about the crime like name and address of the criminal, type, description, time and date of crime, etc.



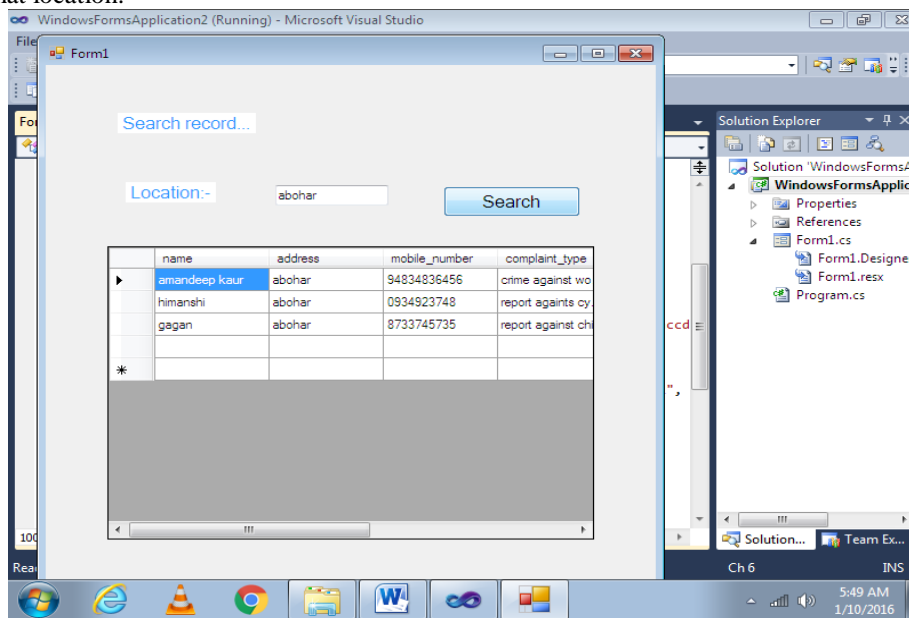
Once the data is entered successfully, it is being stored in the database from where the relevant and useful information can be retrieved whenever required.



B. Crime Information Retrieval and Analysis Module



Crime data Information retrieval module will identify crime hot spots and crime zones of a particular region on certain crime types for a specific period. This interface will provide a tool for making an online query and based on the query, crime hot spots are identified. The user can select any particular location to retrieve information regarding the crime record of that location.



A user can also search records of any year as well as multiple years with the help of Year Selection Input Dialog Box, which will appear after selecting a year. The module has also provided the facility to select crime types which helps the user for analyzing crime hot spots and crime zones of general type of crimes without going into the specific details. The results of query consist of crime hot spots, high crime zones, moderate crime zone and low crime zones based on the average density of these crime. Cluster center as average density of various crime zones are also given in the results of the query interface. The results obtained using proposed adaptive query interface will be helpful in identifying the crime hot spots, predicting crime trends for the crime hot spots which will ultimately help in controlling the crime. The user can also save the results of specified query into a text file and also analyze the results by using Data mining tools. The system is faster to implement and easier to use. It will give an edge to the police to respond and thereby serve the people better. The system provides a user-friendly environment to analyze huge crime database. The traditional way of executing the queries is the extraction of records and aggregates them for every execution. This is more time consuming process because of rescanning of database every time and required a specialized user to extract the information from the database. The proposed crime analysis tool eliminates the rescanning of the database for every new query as well need of skill users. It provides the user an interactive and fast way to carry out process of identification of crime hot spots and crime zones as well as data comparison among various area of interest. Interaction of many relational tables is required for analyzing crime data since not all information required for crime analysis is stored in a single table. The system extracts the records from these tables and aggregates them for further online querying.

IV. CONCLUSION AND FUTURE SCOPE

As the crime data is increasing in very large quantities globally as well as in India, thus motivating professionals to use advanced and efficient techniques for analysis and identification of crime. Data mining as an analysis and knowledge discovery tool has immense potential for crime data analysis. As is the case with any other new technology, the requirement of such tool changes, which is further augmented by the new and advanced technologies used by criminals. All these facts confirm that the field is not yet mature and needs further investigations. Another point noted is that the crime rate is increasing and crime prevention has become an upheaval task. The legal force departments around the world are required to remain ahead in the eternal race between law breakers and law enforcers. Various software discussed in this paper has all been adapted for use in crime analysis but were not created specifically for that purpose. These applications designed specifically for crime analysis have been created to perform functions that are not available in other existing software. Thus, it can be understood that, even though several solutions to solve the problem has been proposed it can be seen that a perfect solution to each city, state and country is still elusive. Moreover, usage of existing data mining techniques is extensive in creating crime analysis tools. As research in improving data mining techniques like clustering and classification is still active, the tools developed can also be improved by improving the underlying data mining techniques.

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